Can SW radio detect earthquakes?

Evidence has been mounting that it might be possible to detect earthquakes by measuring the changes in the ionosphere. Our RF-Seismograph [1] measured spikes and signal dropouts on 31 Nov 2018 that could not come from space, due to solar inactivity (see case study in article [2]). It also caught the eye of the RF-Seismograph team. We went and investigated the phenomena and found a culprit: Earthquakes! Now, the RF-Seismograph team has been collaborating with Earthquakes Canada [3] to find a correlation between HF propagation and earthquakes. Earthquakes Canada gave us a list from US Geological Survey (USGS) [4] with 171 earthquakes of greater than Magnitude 6 (M6+) [5] for the 4 years the RF-Seismograph has been collecting data.

We have recreated the data of the propagation and noise level measurements on days that have an M6+ earthquake and see how much of a change there was visible. We also believe that tsunamis create RF-signatures and will further investigate on this.

The RF-Seismograph uses an HF radio, a 12kHz low intermediate frequency (LIF) interface to decode the IF via a sound card and a 6-band vertical antenna to receive and record RF background noise and log the data into files. More info on the LIF device is at [1].

How do earthquakes create the electromagnetic fields that change propagation?

This was covered in some detail in the October 2018 edition of *Scientific American* in the article Earthquakes in the Sky [6]. Briefly, there is a piezoelectric effect when rocks slide and vibrate on top of each other. Micro-fractures in the rock release vast amounts of free electrons, which move up to the surface (or sea-floor) and circulate around the quake area. Electromagnetic fields start to emerge out of the earth crust and move upward towards the ionosphere. Since the ionosphere contains charged particles, the magnetic field interacts with the ions and creates a hole or a dome of charged particles, affecting radio waves passing through (see Figure 1). The magnetic field lines reach into the ionosphere and disturb or bend the layers, breaking existing radio paths.

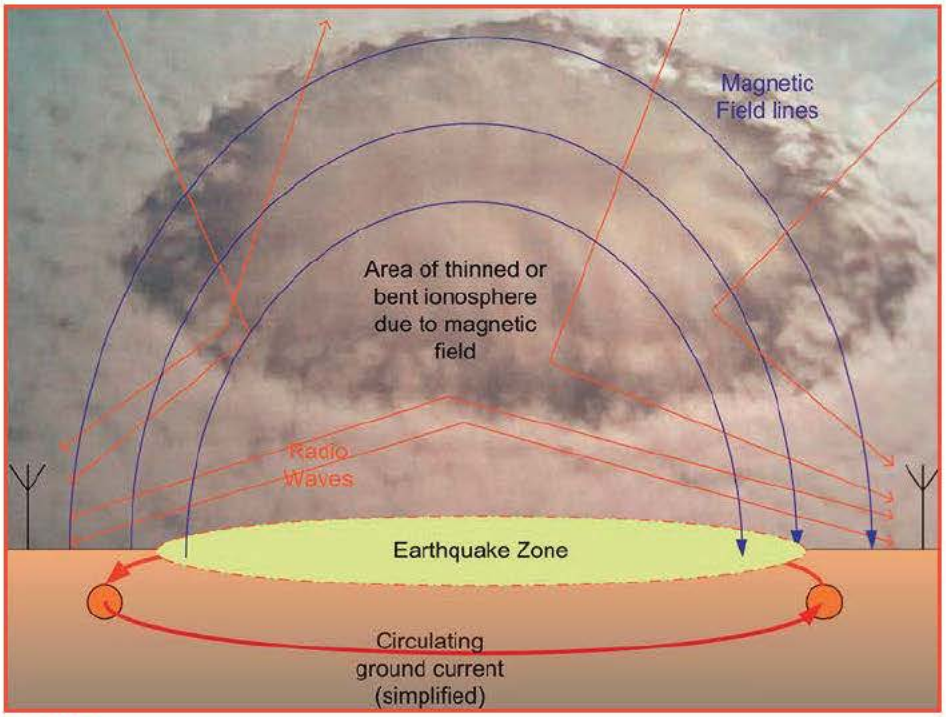

FIGURE 1: A conceptual look at an earthquake affecting the ionosphere.

Thus the signals that the RF-Seismograph receives drop out!

Figure 2 shows the equivalent of a magnetic field shooting out of the surface of the sun. Because of the hot plasma, the field lines are visible. This process on the Sun is much more energetic than an earthquake here on Earth, but the physics are the same.

What do we see on the RF-Seismograph?

Figure 3 shows the different stages of an earthquake as seen by the RF-Seismograph. This data refers to a magnitude 5.0 event, that occurred 256km south-west of Point Hardy, North Vancouver Island, British Columbia, Canada.

The first effect we see is an energy buildup – the noise level increases on the 80m band (red trace), starting at 000UTC. This is quickly followed by disruption of the 40, 30 and 20m bands – there is a communication dropout (the signal strength lines go flat, showing that no signals are being received).

The earthquake releases at 0423UTC (marked with the dashed line). As with most earthquakes we have monitored using the RF-Seismometer, in this example the energy buildup and radio blackout continues for approximately the same duration as the time before the quake (2 to 3 hours), giving a total disruption time of 4 to 6 hours.

After the energy is released, the ionosphere starts to rebuild itself slowly and normal communication resumes, shown by the increase in signals on the traces.

The 4 year propagation vs earthquake study

Why is it so difficult to prove that earthquakes have electromagnetic properties? In previous studies the measurements were done on location, mostly using VHF radios. Furthermore, only one specific quake was measured. This makes it very hard to catch the quake in its act. In order to actually measure the effect on propagation, one has to be at least 500km (~300 miles) away from the quake. This is necessary because we want to measure the radio signals that bounce back from the disturbed ionosphere and, if one stands right in the field dome and transmits radio waves, they are at a steep angle to the field lines and will not bounce back easily.

FIGURE 2: Photo of the surface of the Sun showing the magnetic field lines of a sunspot. The hot plasma makes the field lines visible. (Image credit: TRACE-NASA).

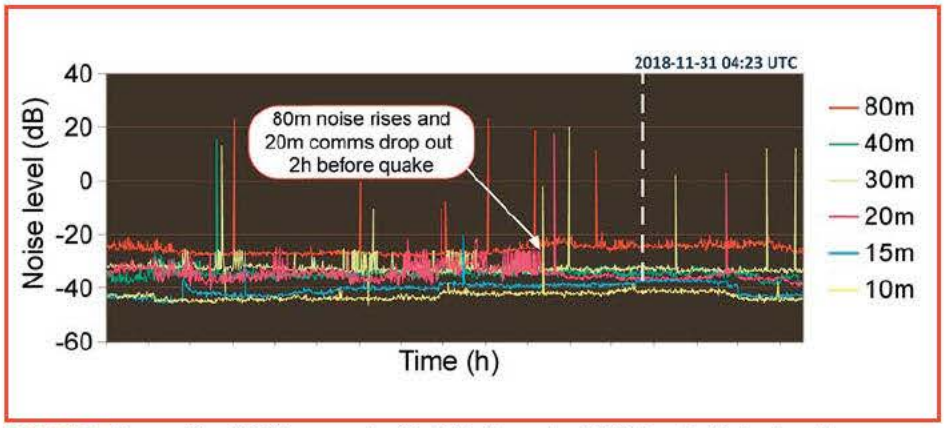

FIGURE 3: Propagation RF-Seismograph plot of 31 November 2018 (see text) showing clear evidence of propagation disturbance before, during and after an earthquake.

So why is this study different? Once we realised the very chaotic nature of earthquakes and linked this to the RF noise they generate (which is electromagnetic white wideband noise – to almost 0Hz), we understood why it is possible to study almost all earthquakes from one location (besides triangulation). By using HF and considering the fact that earthquakes can create RF signals that have several megawatts of power output (possibly even more), they are easy to pick up. One only needed to correlate the time of the quake and look for the changes in propagation.

We studied 171 earthquakes, all M6+ events, from the beginning of our recordings in August 2016 until this report was written (early 2019). Events were provided by USGS and the quality of the data is high. We have 961 days of recorded data (minus one, lost due to irrecoverable data corruption), which include 171 M6+ quakes – that amounts to one major quake every 5.6 days. Approximately 17.3% of background noise is affected by these strong events. Since we did only look at M6+ events, we can conclude that a lot of the background noise we monitor is created by smaller seismic events as well (and there are a *lot* more of them). If one looks at smaller quakes (<M3.0), the earth really never stops shaking. There is a lot of energy even in small quakes and they are the major source of the rumble one hears when a HF rig is set to 160m or 80m.

We found that only 15 quakes did *not* have RF noise associated with them. In 26 cases the time of the disturbance did not match the time stated in the USGS report.

In 122 quakes (72%) we were able to see a noise increase on the 80m band either before, after, or both before and after the quake released. The 'before and after' is the most common circumstance noted. More analysis is needed on this data.

There is a good introduction to the study of earthquakes at [7], plus several more references at the end of this article.

Conclusion

Now we come to the big question: is it possible to predict earthquakes and evacuate people before they release?

With the provided measurements it seems that most quakes have a precursor noise level that could be detected and used to alarm a region. It will certainly add another useful tool to the measurements of quakes and it will create more certainty that a region is actually getting shaken to a level that causes damage and cost of life. Combined with regular seismographs, it could improve prediction, but clearing an area and then have nothing happen is the worst nightmare of any official; or even worse, after the all clear is given, disaster strikes.

Join in!

The study is still continuing and we need your help to set up more monitoring stations. You can freely download and install RF-Seismograph for Linux and Raspberry Pi from [8] and the MDSR software for PC from [9]. The MDSR can use an FT-817, FT-857, FT-897 or an FT-950 (in fact any 455kHz-IF transceiver such as the IC-718 or IC-703 will work). You'll also need a 12kHz low-IF converter (LIF). Full details are on the project website [10].

Websearch

[1] http://users.skynet.be/myspace/mdsr/index.html
[2] Access to Study for 2017, 2018 (2019 is part of 2018) http://www3.telus.net/public/bc237/MDSR/Matches-RF-Seismograph and Seismic data for 2017.pdf and http://www3.telus.net/public/bc237/MDSR/Earthquakes%20visible%20with%20RF-Seismograph%202018.pdf
[3] http://www.earthquakescanada.ca
[4] https://www.usgs.gov/
[5] https://en.wikipedia.org/wiki/Seismic_magnitude_scales
[6] Scientific American October 2018, 'Earthquakes in the Sky', www.ep.sci.hokudai.ac.jp/~heki/pdf/Scientific_American_Vance2018.pdf
[7] http://www3.telus.net/public/bc237/MDSR/IntroductionRF-SeismographandEarthqakes.pdf
[8] https://groups.io/g/MDSRadio/
[9] http://users.skynet.be/myspace/mdsr/
[10] https://scistarter.org/rf-seismograph

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